

Aerogels

Lightweight, strong, and with many special properties for the modern era



Aerogels are unique materials—both their pores and particles are smaller than the wavelength of light. Discovered in the 1930s, they were initially thought to have no practical use. However, with new, improved processing techniques, and with newly developed varieties (such as those developed at LLNL), aerogels are beginning to prove their commercial potential.

Nearly as light as air

Using a new, two-step condensed silica process, we have produced the lightest aerogel ever made—one that contains 99.98% air. In recognition of this achievement, *Research and Development Magazine* named LLNL's silica aerogel one of the 100 most valuable technologies developed in 1990; *Popular Science* praised LLNL's silica aerogel as one of the "100 Best of What's New for 1990."

Silica (silicon dioxide) aerogels consist of bonded silicon and oxygen atoms joined into long strands and then into beads randomly linked together with pockets of air between them. Silica aerogels are an amorphous form of "common sand"—nonflammable, nontoxic, and environmentally safe. They can be made less dense than air (when the air is removed) and are more than 30 times lighter than earlier aerogels. They are excellent sound insulators.

APPLICATIONS

- Particle and gas filtration systems for inorganic media
- Solar energy collection
- Special-purpose packaging
- Lightweight insulation
- Space applications

Rapid processing

We make silica aerogels in a patented process that begins with a partially hydrolyzed silica solution to which we add water, a solvent, and a basic catalyst to form a gel. We then remove the solvent by supercritical conditions in an autoclave and replace it with air. LLNL's process takes a few hours; other methods can take days or weeks. Moreover, the process is flexible enough to let us produce aerogels with a wide range of densities—from 0.7 to 0.001 g/cm³.



A new class of organic aerogels

At LLNL, we have developed an entirely new class of organic aerogels. Organic aerogels are stiffer and stronger than silica aerogels and are measurably better insulators. They have extremely high thermal resistance—six times more resistance than fiberglass insulation. Organic aerogels can be converted to pure carbon aerogels and still retain many properties of the original aerogel, in addition to becoming electrically conductive.

Our aerogels:

- Can support over 1500 times their own weight
- Contain exceptionally large internal surface areas—400 to 1000 m³/g—about the size of one to two basketball courts
- Are transparent, giving rise to the nickname "frozen smoke"
- Provide exceptional mechanical integrity and optical clarity
- Are exceptionally poor conductors of heat and sound.

Availability: LLNL's aerogels are available now. We are seeking industrial partners with whom we can develop commercial processing techniques and applications.

Contacts

Lawrence Hrubesh
 Phone: (510) 423-1691
 Fax: (510) 423-4897
 E-mail: hrubesh1@llnl.gov
 Mail code: L-320

Richard W. Pekala
 Phone: (510) 422-0152
 Fax: (510) 423-4897
 E-mail: pekala1@llnl.gov
 Mail code: L-322